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Equity Analysis in Public Policy Formation

Illinois Univ. at Urbana-Champaign

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Athens, GA

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EQUITY ANALYSIS IN PUBLIC POLICY FORMATION

by

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This report identifies several equity criteria that are necessary in conducting public policy analysis. The generally accepted economic equality criteria is augmented by shared consequences, earned rewards, and intergenerational equity criteria. In addition to suggesting that these criteria are appropriate for analyzing alternative public policies, the report suggests procedures for developing quantitative estimates of the equity impacts for three of the four criteria. The case of alternative policies for the control of soil erosion as a means of improving water quality and maintaining productivity is used as the reference point in the report.

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FOREWORD

As environmental controls become more costly to implement and the penalties of judgment errors become more severe, environmental quality management requires more efficient management tools based on greater knowledge of the environmental phenomena to be managed. As part of this Laboratory's research on the occurrence, movement, transformation, impact and control of environmental contaminants, the Technology Development and Applications Branch develops management and engineering tools to help pollution control officials achieve water quality goals through watershed management.

Agricultural sources contribute significantly to water pollution problems in many areas of the United States. This report describes part of a 2-year study in which the social, economic, legal and institutional issues involved in the management and control of pollutants from agricultural nonpoint sources were examined.

David W. Duttweiler
Director
Environmental Research Laboratory
Athens, Georgia

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This report was submitted in partial fulfillment of Contract No. 68-03-2597 by the University of Illinois at Urbana-Champaign. The report covers the period September 1977 to August 1979.

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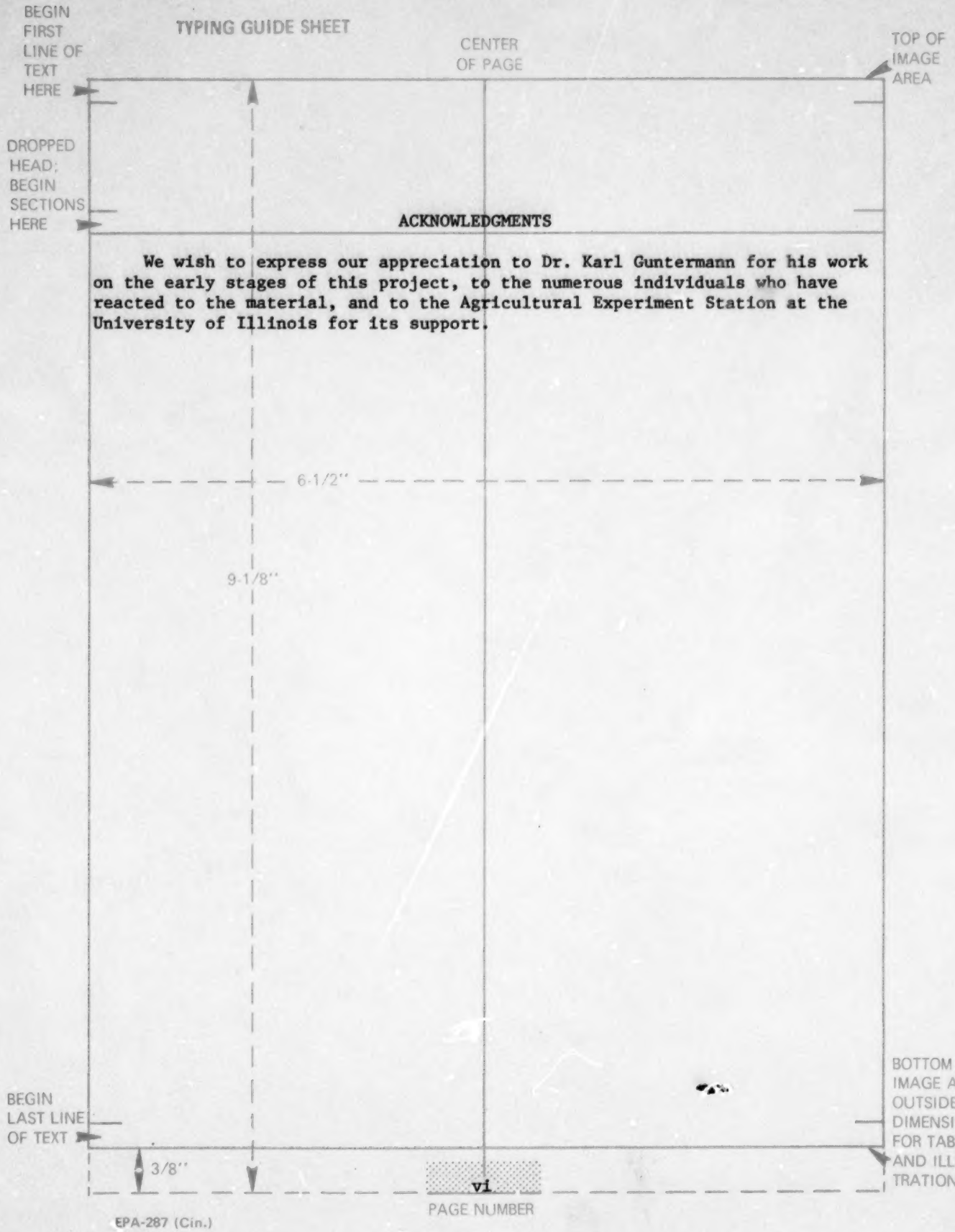
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INTRODUCTION

A standard test of whether a policy is desirable from an economic perspective is to determine if it is efficient and equitable. A policy that makes some individuals better off and none worse off is classified as efficient. In general, those policies for which the sum of the benefits is greater than the sum of the costs are also considered efficient. Obviously, any policy that makes all individuals worse off is inefficient, and, in general, any policy for which the sum of the costs is greater than the sum of the benefits is also classified as inefficient. Techniques such as cost-benefit analyses that measure the efficiency of public-policy changes have been developed and used for a number of years and are the subject of continuing reappraisal.

In the case of equity, economists are generally concerned with the distribution of income. They assume that a policy transferring benefits from the rich to the poor is equitable and one transferring income from the poor to the rich is inequitable (Sassone, 1978). Policies are also, in general, equitable when the sum of the impacts to the poor is positive and greater than the sum of the impacts to the rich (Sassone, 1978). Policies for which the sum of the impacts on the poor is equal to the sum of the impacts on the rich might be considered neutral with respect to equity.*

Our concern in this report is not with the evaluation of public policies with the specific or primary objective of generating a more equitable society. Our goal is to suggest an approach that can be used in analyzing the equity implications of alternative public policies being considered as a means of accomplishing objectives other than equity. We begin with a brief discussion of the foundations of the concept of equity. This analysis concludes that a single measure, such as the distribution of income, is generally not adequate and certainly is not so for the type of analysis we suggest. Rather, we will indicate that, as others have suggested, several equity criteria need to be considered by a policy analyst who is seriously attempting to reflect the beliefs of society. We then suggest several criteria we believe to be reasonable candidates for consideration.

The next section of this report will detail the selection of a measurement statistic. While recognizing that no statistic can be completely acceptable, we have selected one that we feel is workable and have developed procedures for implementing each suggested criterion. We will conclude with observations on how these statistics could be developed especially in the

*Rich and poor, however, are relative terms. An individual living in an impoverished area may be considered rich by his neighbors but be poor by national standards. A national policy that benefited this poor individual might be condemned at the local level as being inequitable.

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analysis of a soil-erosion, water-quality policy.

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In an earlier report (Seitz et al., 1978) the possibility of utilizing several equity criteria was raised and discussed. In this report the equity criteria have been extended and developed in considerably more detail. A procedure for making numerical estimates of the equity impacts of various policies has been developed. Remaining for future work is the application of this procedure to a real problem.

Concept of Equity

Equity is derived from the Latin *aequitas*, meaning equal or fair (Oxford English Dictionary). Although these two elements of equity should complement one another, it is not always clear that they do. An equal distribution need not be a fair distribution. Thus it has often seemed expedient to view equity as either equality *or* fairness.

Social philosophers have often stressed equality to make their definition of equity more precise. "Equity," proclaimed Thomas Hobbes, is a "Law of Nature [characterized by] the equal distribution to each man of that which in reason belongeth to him" (Hobbes, 1651). Equality is clearly the dominant theme in this definition. Fairness is left entangled in the matter of just what belongs "in reason" to whom. Other philosophers, however, stressed the fairness of equity. "...Aristotle was among the first to pose an 'equity' theory of justice.... He alluded to two forms of justice: (1) *Equal Justice* (rewards are distributed equally among men); (2) *Distributive Justice* (rewards are distributed in proportion to men's merit)" (Austin, Walster, and Utne, 1976). Equity implies equal justice or fairness as well as equality. Thus, the fairness aspect of equity is the main factor in determining when to apply the equality rule, that is, in determining who should be treated equal to whom and on what basis.

Economists have adopted the term *equity*. But, unable to cope with the conflicting elements of the term, they, too, have tended to equivocate on its denotation. Lacking a definitive meaning, economists have not been able to properly integrate equity into the core of economic theory.

Some economists, for example, have recently defined equity as simply fairness (Pazner and Schmeidler, 1974; Varian, 1974; Daniel, 1975).* Since *fairness*, in ordinary usage, is no more precise a term than *equity*, these theorists have been forced to define *fairness* strictly for their use. Regrettably, their definitions (e.g., a fair distribution as one in which none of the recipients envies any other) lack both intuitive appeal and practical usefulness.

Equity is also used by economists as a synonym for equality (Sahota, 1978). Although *equality* does offer economists more precision in analysis, it does so by neglecting its denotation of fairness. In particular, empirical studies of distributional effects tend to equate equity with equality

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*A concept of fairness underlies Rawls' definition of distributive justive although Rawls does not analyze equity *per se* (Rawls, 1971).

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in judging changes in income distribution (Horner and Dudek, 1977; Miller and Gill, 1976). Often, as noted above, this distribution-of-income meaning is assumed by those analyzing proposed public actions to be the only definition of *equity*. There are two major problems with this approach. First, many believe that it is not possible to apply this criterion rigorously, and, second, this criterion is not the only one accepted by society as a determinant of what is fair or equitable.*

Turning first to the question of implementing the distribution-of-income criterion, several authors have commented on the difficult or impossible nature of such a task. "Indeed, the deepest problems of distributive justice are concerned precisely with this question: How do we divide the social product when agents can contribute differently to the formation of that product? . . . Thus, if we have an efficient allocation where each agent (weakly) prefers his consumption-leisure bundle to any other agent's, that allocation is fair." He then goes on, however, to say, "The problem with this approach is simply this: Fair allocations, as defined above, will not in general exist even in very regular cases" (Varian, 1974).

Pazner and Schmeidler (1974) conclude their work with the observation, "In addition, for any economy in which there are many consumers and many commodities, we advance the following conjecture: If the labours of at least two individuals command different prices in any technologically efficient production plan, it is possible to define the preferences so that no Pareto-optimal allocation will be fair."

Sen (1970), in his major work on this subject, concludes by indicating the difficulty of generating specific solutions. He lists the alternative uses for social decisions (and therefore equity determinations) and the numerous limitations on generating rigorous theoretical constructs.

> What this result possibly reveals (as do other results in the book) is an important difficulty in postulating general conditions on collective choice rules, viz., these conditions are essentially opaque. It is easier to secure acceptance of these conditions than the acceptance of all of their implications.
>
> . . . The difficulties that we encounter in making universal use of even the Pareto rule (the mildest of the mild) outlines the severeness of the problem of postulating absolute principles of collective choice that are supposed to hold in every situation. The simple principles that are normally put forward tend to be essentially 'nonbasic.' ...It seems possible to play havoc with practically all the general principles that are usually recommended for universal application.
>
> Once the nonbasic nature of the usual principles of collective choice are recognized, some of the rigid distinctions must go. For

*Those approaching such questions from the legal perspective would be concerned with fair or equitable systems for resolving disputes and not with the outcome of the decision itself.

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example, in traditional welfare economics, it is conventional to distinguish between Paretian judgments, which are treated as compelling, and non-Paretian judgments, which are treated as 'arbitrary.' This clear-cut dichotomy seems to be inopportune both because the Pareto principle is also partly arbitrary (Chapter 6) as well as because some of the other principles are also compelling in many situations (Chapters 5-7 and 9). An almost exclusive concentration on Paretian considerations has, on the one hand, confined traditional welfare economics into a very narrow box, and has, on the other hand, given it a sense of ethical invulnerability which does not seem to survive a close scrutiny (Sen, 1970).

These authors, then, join others in demonstrating that a rigorous determination of the equity of alternative programs is not possible. In fact, the literature in the area of social choice or equity is strewn with impossibility theorems.

The second major problem we face in defining equity as distribution of income--and one that is clearly linked to the first--is that there is more than one equity criterion. Leventhal (1976), in summarizing his discussion of the allocation process used by individuals in responsible positions, observed:

> Allocation norms are important determinants of an allocator's decisions. Each norm specifies criteria for identifying a fair distribution. However, several norms are often salient at one time and each may favor a different distribution of reward. Thus, an allocator must decide which allocation norm or combination of norms to follow. Often, he follows those norms which are approved and accepted by others.

Walster, Berscheid, and Walster (1976), after stating that under certain conditions a consensus as to what is equitable will be reached in society, go on to point out significant difficulties.

> However, the preceding formulation makes it clear that ultimately, equity is in the eye of the beholder. An individual's perception of how equitable a relationship is will depend on his assessment of the value and relevance of the various participants' inputs and outcomes. Participants themselves, even after prolonged negotiation with one another, will not always agree completely as to the value and relevance of various inputs and outcomes . . . Aesop acidly observed that "The injuries we do and those we suffer are seldom weighted on the same scales." If participants do calculate inputs and outcomes differently--and it is likely that they will--it is inevitable that participants will differ in their perceptions of whether or not a given relationship is equitable. Moreover, "objective" outside observers are likely to evaluate the equitableness of a relationship quite differently than do participants.

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Homans (1976) said:

> Perhaps we should not lump everything remotely concerned with fairness together under the single rubric of equity theory, but use different names to indicate what sorts of equity we are talking about. We might then be better able to recognize how the different kinds are related to one another.

Sen (1970) concluded his work with the observation:

> Finally, it is worth emphasizing that while "pure" systems of collective choice tend to be more appealing for theoretical studies of social decisions, they are often not the most useful systems to study . . . Both from the point of view of institutions as well as that of frameworks of thought, the impure systems would appear to be relevant. The relative allocation of space in this book reflects a belief, which we have tried to defend, that while purity is an uncomplicated virtue for olive oil, sea air, and heroines of folk tales, it is not so for systems of collective choice.

Baumol (1978) suggested that one search for reasonably equitable solutions in the following manner:

> I suspect that a promising alternative is the viewpoint that there is no *one* just solution. Rather, there is a range of solutions which are not clearly unjust. Similarly, there are in most cases many solutions that *are* surely unjust. While we are virtually certain to fail in any attempt to single out *the one* just price, it takes little imagination to think of . . . [solutions] which "reasonable" persons will all consider grossly unfair.

Our approach heeds the advice of these authors by recognizing the existence of several equity criteria and by attempting to provide a means of identifying those policies that would be judged grossly inequitable by a segment of society.

Sen (1970) said:

> Some choice procedures work very well for some types of choice and some sets of individual preferences but not for others, and naturally our evaluation of these procedures must depend on the type of society for which they may be considered.

To the extent that people in a society are affected by the same sets of institutions--schools, churches, bureaucracies--and are subjected to the same natural events, it might be expected that they would share similar conceptions of fairness. Because not all individuals in this society are exposed to the same set of circumstances, of course, it is obvious that there will be disagreement concerning the equity criteria to be employed. Since people learn from and act on the basis of experience, it follows that beliefs

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concerning the appropriate equity criteria may change over time. Such changes will, however, occur very slowly because these beliefs are a product of a complex of attitudes and values strongly held by individuals (Seitz, et al., 1979). It is from this complex of evolving attitudes or beliefs held by the individuals comprising a society that a policy maker must search for appropriate equity criteria to employ in the evaluation of policy alternatives. Our focus on public policy formulation renders the intriguing issue of international equity less relevant and thus we do not address it here.

Horizontal and Vertical Equity

In addition to the specification of several equity criteria, it is necessary to consider two components of the equity measures selected, horizontal and vertical. Horizontal equity is the equal treatment of persons in equal positions. This component emphasizes the equality aspect of equity. Vertical equity, or "how the [treatment] of people in different positions should differ" (Musgrave, 1959), emphasizes the fairness concept of equity. This welfare interpretation captures the essence of equity but, as generally presented, inadequately defines vertical equity. An adequate definition is necessary because, as Musgrave (1959) has noted, horizontal equity has no meaning if vertical equity is not well defined. Equality becomes a meaningless rule of equity unless the circumstances for applying the rule are known.

A proper definition of vertical equity requires that: (1) a number of sets of equals be specified and (2) the treatment of different sets of equals be specified.

Specifying groups of equals requires that a set of significant characteristics--such as income, age, education, occupation, and wealth--be selected for distinguishing one type of individual from another. To say that all characteristics are significant is simply to say that each individual is unique. This basis of grouping implies that there can be no generalized rules of treatment, and thus it is not particularly useful. At the other extreme one could say that no characteristics are important; all people are alike and should be treated equally. This extreme is not any more useful than the other. To be equitable a policy would have to treat individuals equally in every respect, an impossible goal of questionable merit.

The second problem in specifying the vertical component of equity--how to treat people in different positions differently--demands an explicitly normative judgment. Assuming that one or more of the significant characteristics of the population can be changed by political action, the differences among sets may be diminished, maintained, or increased.

Horizontal equity is attained, for example, when all individuals in a given occupation have equal incomes. To assure vertical equity, one needs to judge whether the remaining income differences among occupations are equitable.*

*It is assumed that society prefers to change the level of inequality by adjusting incomes rather than by altering occupations. Conceivably, one could diminish inequality by eliminating certain occupations. An increase in the minimum wage, for example, often eliminates some low-paying jobs (continued)

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Other Distinguishing Characteristics

The previous section obviously implies that income and impacts on income are important to attempts to specify equity criteria. Thus occupation will also be an important characteristic. Other characteristics are also important for many policy issues. Policy makers may need to consider groups of individuals in categories such as consumers, workers, recreationists, pollutees, the elderly, renters, homeowners, and students when they analyze policy alternatives that would affect these groups. The emergence as a political force of special or single-issue groups will assure that their interests will be considered. The policy maker needs to be equipped to deal with such claims.

Equity Criteria

There are many possible criteria of fairness or equity, each implicitly specifying a general set of significant characteristics for judging vertical and horizontal equity. The validity or moral force of these criteria depends upon their acceptance by society. The four equity criteria suggested here are believed to have broad popular appeal although they may not be appealing when pressed to their extremes. However, in practice the criteria would not likely be used at the extremes. Rather, the criteria will be used to judge policies that permit significant inequality to persist under all criteria. Over this range of policies, the criteria reflect the hypothesis often put forward that Americans would prefer less economic inequality (Okun, 1977). Public policies should at least have favorable equity impacts to the extent "possible." Stated briefly, the criteria are:

1. Equality - The benefits of society should be shared equally by all.

2. Shared Consequences - The benefits or costs of public policies should be shared equally by all.

3. Earned Rewards - Individuals should pay for benefits received and be compensated for costs incurred.

4. Intertemporal Fairness - Long-term risks associated with public policies should be minimized.

We shall examine these criteria in two forms: (1) abstractly, without reference to specific groups of individuals (vertical equity is defined by one significant characteristic), and (2) with specific reference to groups affected by nonpoint-water-pollution-control policies (vertical equity is expanded to include additional significant characteristics). All the criteria, in both forms, depend upon earnings or income that is broadly defined to include the impacts of public goods and externalities.

instead of increasing the incomes of those holding jobs. Vertical equity, in this case, would focus upon what differences in work should be permitted among different income classes. It is also recognized that the difference in incomes among occupations is a factor which motivates the reallocation of resources.

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GENERAL CRITERIA OF EQUITY

Equality

A partial measure of equity is equality. Often, however, economists use equality as equity's principal criterion (Atkinson, 1970; Mera, 1967). They justify this usage not because complete equality is either possible or desirable but because equalization of certain characteristics is perhaps feasible and desirable. Income is the characteristic most often cited (Sahota, 1978), but wealth, education, and several other variables have also received attention. We shall focus our attention on income equality.

There is an ongoing controversy as to whether income inequality is predominantly a political or a natural phenomenon (Paglin et al., 1976). Some economists argue that age differences, varying leisure preferences, and genetic heritage account for much of the inequality in income (Sahota, 1978). Since income inequality is in large part not subject to political control, the argument continues, our economic system may be far less inequitable than its critics allege. Other economists assert that institutional factors are most important in determining income inequality and that economic inequity should be a matter of public concern (Sahota, 1978). The task of untangling the natural and institutional causes of income inequality has not been completed, so it is difficult to know how much income inequality to attribute to institutional sources.

Ideally, income, age, personal leisure preferences, and genetic factors would all be considered significant characteristics in defining the equality criterion. However, since the conflicting influences of these characteristics cannot, at present, be separated, we are forced to rely upon income, the principal dominant determinant of inequality, as the sole basis of the equality criterion.

Any reduction in income equality, then, is a move toward a more equitable state. By receiving equal incomes, individuals receive equal treatment. Symbolically this criterion is expressed as:

$$Y_1^Q = Y_2^Q = Y_N^Q \qquad \text{(Eq. 1)}$$

where

Y_n^Q stands for the income of individual n over time-period Q and

N is the number of people in the society.

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When the concept of horizontal and vertical equity is considered, the equal income within groups remains, but some differences among groups may be acceptable. In our application below, any reduction in income differences, horizontal or vertical, is viewed as an improvement.

Shared Consequences

Equal sacrifice has long been an equity criterion in judging tax measures (Mill, 1969; Musgrave, 1959). It has served as a moral defense for proportional and progressive taxation. Equal sacrifice in times of crisis, such as war, has been an especially strong moral argument against profiteering. Recently, advocacy of an equitable sharing of the burdens of reducing energy use is rather widespread.

The shared-consequences criterion of equity is based upon the equal-sacrifice principle. The principle of equal sacrifice, however, may be asymmetrically applied. While the burdens of crises and the costs of public programs are to be shared, the benefits of prosperity, generated publicly or privately, may or may not be shared. Proponents of equal sacrifice also disagree on which sacrifices are to be shared. Some, such as J. S. Mill, would require all expenses of government to be shared (Mill, 1969; Musgrave, 1959). A narrower interpretation advocates sharing only the sacrifices of crises (Kristol, 1977).

The shared-consequences criterion is a symmetrical interpretation of the equal-sacrifice principle. Under this approach, shared consequences applies to all benefits and burdens of the government policy being analyzed. This criterion is measured in terms of a ratio of the net incremental change in income caused by a policy divided by the new income total.* Symbolically, shared consequences is expressed as

$$\frac{\Delta Y_1^Q}{Y_1^Q} = \frac{\Delta Y_2^Q}{Y_2^Q} = \frac{\Delta Y_N^Q}{Y_N^Q} \qquad \text{(Eq. 2)}$$

where

Y_N^Q is defined as in the equality criterion and ΔY_N^Q is the change in income for n over period Q.

This criterion can be applied over individuals within a group (horizontal equity) or among groups of similar individuals (vertical equity).

Earned Rewards

The earned-rewards criterion is a reflection of a fundamental axiom of capitalism: individuals' incomes are determined on the basis of their

*Shared consequences could be measured by the net incremental change in income rather than by the proportional change. Sharing consequences proportionally, however, seems intuitively more fair than equal absolute shares. This criterion reflects the preference for a "fair share" rather than an equal share.

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productive contribution to society, as valued by the market. If one allows productivity to be determined outside the market, the axiom--and the earned-rewards criterion--are central to other economic systems as well.

Earned rewards is a deeply rooted standard. Classical economists made use of it in advocating taxation according to benefits received (Musgrave, 1959). Environmental economists have used it in advocating the "polluter-pays principle" of equity (Kneese and Bower, 1977). In each instance an individual is expected to receive just compensation for his contribution. The concept of what is "just" may be evaluated by the market, in the case of labor or commodities, or by the government, in the case of public goods and pollution. In both cases compensation varies with the contribution.

Earned rewards could be applied either to total income or to incremental income (i.e., income changes generated by the policy). The total-income approach is exceedingly complex and has large data requirements. One must also recognize that most claims under this criterion will be a function of the existing distribution of rights and expectations. If one accepts this without question, the history, morality, and legality of this distribution of vested positions would not be questioned. Since one surely does not wish to utilize an equity standard to defend a socially indefensible position, the analysis should attempt to move from this result to the degree possible.

For this reason, primarily, the earned-rewards criterion is assessed on the basis of the incremental-income aspects of the policy. Thus one would attempt to determine whether the implementation of a policy would result in the relationship between the individual's net contribution to society being (more nearly) equal to the individual's net reward from society, with regard to the activity in question in the policy. In symbolic terms:

$$\frac{B_1^Q}{C_1^Q} = \frac{B_2^Q}{C_2^Q} = \frac{B_m^Q}{C_m^Q} = \frac{B_N^Q}{C_N^Q} \qquad \text{(Eq. 3)}$$

where

B_m^Q equals the benefits derived by individual m in time period Q from activities affected by the policy under analysis.
C_m^Q equals the costs incurred by the individual m in time period Q from activities affected by the policy under analysis.

Again, horizontal equity would relate to all individuals in the same group whereas vertical equity would be measured over groups.

Intertemporal Fairness

During the last decade, increasing concern has been expressed over environmental degradation and resource depletion (Page, 1977; Peterson, 1979; Walter, 1975). Careless production practices and excessive material consumption, it is said, are endangering the well-being if not the very existence of future generations. Fishhoff et al. (1977) analyzed the risk associated with 30 types of activities. They are able to explain variations in

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the levels of risk perceived by individuals although this area is, of course, controversial. Wildavsky (1979) argues that "no risk is the highest risk of all" because, if the present generation expends excessive resources on futile attempts to eliminate risks, insufficient resources will be allocated to other productive enterprises. Page's treatment of the intertemporal-equity issue is quite persuasive. He indicates the need to move beyond the structuring of an efficient market over time or, more appropriately, over generations (Page, 1977).

The discounting of future income is one of the common problems that cause this issue to be raised. If one simply uses a market discount rate of 10 percent or more, any dollar of income to be received more than 50 years in the future will be worth less than one cent. This discount rate can be used to justify the use of resources by the present generation rather than their conservation for future generations because the value of future production is insignificant. One problem with this approach is that the current high interest rates include a significant inflation factor. Correcting for this influence requires either the selection of a much lower discount rate or much higher prices of products produced in the future.

Even if the inflation problem is satisfactorily handled, an issue remains. Some argue that funds are invested or resources used to create productive resources for future generations. Others point to the use of a finite stock of resources to create consumer goods or "durable" goods with life expectancies of less than 50 years. The former group expects constantly rising levels of living over generations, while the latter believe that a reduction, perhaps severe, is probable. While the implications for appropriate public policy, at least on many issues, may be quite different, persons of both beliefs would likely argue that concern for future generations is appropriate.

The handling of toxic and radioactive wastes is one of the more motly debated contemporary issues. The potential impact on future generations in terms of the imposed management costs and the potential health and possible genetic effects are major aspects of this issue. In this case the equity criteria could perhaps be appropriately termed least-risk criteria. The objective would be to avoid the adoption of technology or practices that place future generations at risk. Soil erosion arouses a similar concern because the loss of productive topsoil may pose the same type of risk. Eckholm (1976) discussed this problem from an international perspective. Seitz et al. (1978) show that the problem can be expected to become severe in the U.S. Corn Belt in less than 100 years with current production techniques.

With perfect foresight one could look ahead to see how current economic practices, such as discounting, will affect future generations (intergenerational equity). Under those circumstances, intergenerational equity would be a variant of intragenerational equality: real incomes would tend toward equality across generations. A policy that failed to ensure the survival of humanity would be inequitable since an infinite number of generations would be, euphemistically speaking, without income. In general, the policy that permitted humanity to survive the longest, with a "reasonable" level of living, would be the most equitable.

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Lacking perfect knowledge, the intertemporal equity criterion judges intergenerational equity on the basis of risk. Among alternative policies, the one having the least risk of catastrophe is considered the most equitable because it offers the best assurance of continuity. Over a wide range of possible income distributions, ranking policies on the basis of risk serves as a proxy for ranking on the basis of income. A policy that ensured survival for X years, ensuring income to N people over that period, would generally be more equitable than one that ensured survival for X to Y years and income for N to M people, provided Y and M were sufficiently large. Thus the ranking of policies is preserved if risk is the basis of ranking, although it must be recognized that even the project of risk levels is risky business.

Measurement Techniques

Before turning to a discussion of the measurement techniques used in this study, further comments on the equity criteria may be in order. First, these criteria are selected because they are believed to have general credibility in society and because they are relevant to the policy issue of reducing agriculturally generated water pollution through soil erosion control. With respect to this issue, we have indicated the relevance of the intertemporal criterion, and the equality criterion is a consideration in any policy discussion, at least to the extent that it is felt to be inappropriate to knowingly place greater burdens on the poor. The shared-consequences criterion will probably call for everyone in society to share in the cost of providing high-quality water supplies rather than forcing some farmers to bear the costs of a program. The earned-rewards criterion may counter the shared-consequences criterion in that some will argue that those who are causing the problem should pay the full cost of control.*

Finally, it is recognized that in the case of this policy issue and others additional equity criteria may be advocated. In each case the suggested criterion must be scrutinized by policy makers to determine whether it is appropriate. Also, as suggested earlier, these criteria may well evolve over time, so the assessment must be continuous.

To apply any equity criterion it is necessary to determine what income, benefit, and cost data to include and how to calculate the inequality statistic. Three of the equity criteria under consideration here are expressed in terms of an equality relationship. Equity under the equality criterion is a function of equality of incomes. Under the shared-consequences criterion, equity is expressed in terms of the equality of policy impact in proportion to total income. Under earned rewards the relationship between the benefits and costs related to the policy action are expected to approach equality. Intertemporal equity could ideally be expressed in terms of equality of incomes; however, the obvious lack of data on future incomes makes a less formal specification more practical. We turn then to the determination of the means of measuring inequality,

*Such an argument may well hinge on what is thought to be the base level of water pollution from which benefits and costs are calculated. Establishing a base level is likely to be a controversial matter in itself.

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The art of measuring inequality is at least a half-century old (Atkinson, 1970). Dalton pointed out in 1920 that ranking frequency distributions, typically distributions of income, is not an objective process. A definitive technique for measuring inequality does not exist. The ranking of distributions may depend on the measurement technique used.

This difficulty can be appreciated by considering several distributions of income as summarized by the Lorenz curves, the common graphical technique used to report income distributions. In a Lorenz curve the percent of income earned by individuals is plotted against the percent of the population. If all individuals in society had equal incomes, the "curve" would be a straight line at 45° from the origin. In Figure 1, curve A is entirely inside curves B and C, and thus it represents a more equal distribution of income than B or C. The problem occurs when two distributions cross, as in the case of B and C. Distribution B is more equal at low incomes and C is more equal at high incomes (Atkinson, 1970).

The widely used Gini statistic (Layard and Walters, 1978) gives greater weight to income transfers around the center of the distribution than to those in the ends. This fact implies that transfers from the upper middle class to the lower middle class are more desirable than transfers from the lower middle class to the poor (Atkinson, 1970). The Gini statistic is also locally homothetic; that is, it typically weights redistributions the same regardless of the level of inequality. Since intuitively one would want to place a greater weight on redistributions when the underlying distribution is grossly unequal, homotheticity is not generally a desirable characteristic in an inequality measure (Blackorby and Donaldson, 1978). Other conventional statistics--the variance, the coefficient of variation, the relative mean deviation, and the standard deviation--also display properties of questionable value (Atkinson, 1970; Layard and Walters, 1978; Champernowne, 1974).

One partial solution to the problem of hidden bias in inequality measurement is to explicitly include an inequality-aversion parameter in the summary statistic. This procedure is used in the relatively new Atkinson statistic. The Atkinson statistic, however, is unsuitable for distributions with entries less than or equal to zero.

The statistic used in this analysis is a modified version of one suggested by Kolm (1976) as a possible alternative to Atkinson's statistic. It includes an inequality-aversion parameter and will accommodate nonpositive entries. Inequality, I, is measured by

$$I = \frac{1}{\alpha} \text{Log} \sum_{i=1}^{N} \left(e^{\alpha R_i} \frac{1}{N}\right) \qquad \text{(Eq. 4)}$$

where

$R_i = \left(1 - \frac{Y_i}{\bar{y}}\right)^Q$ for the equality criterion

$R_i = (\bar{X}^Q - X_i^Q)$ for the shared-consequences and earned-rewards criteria

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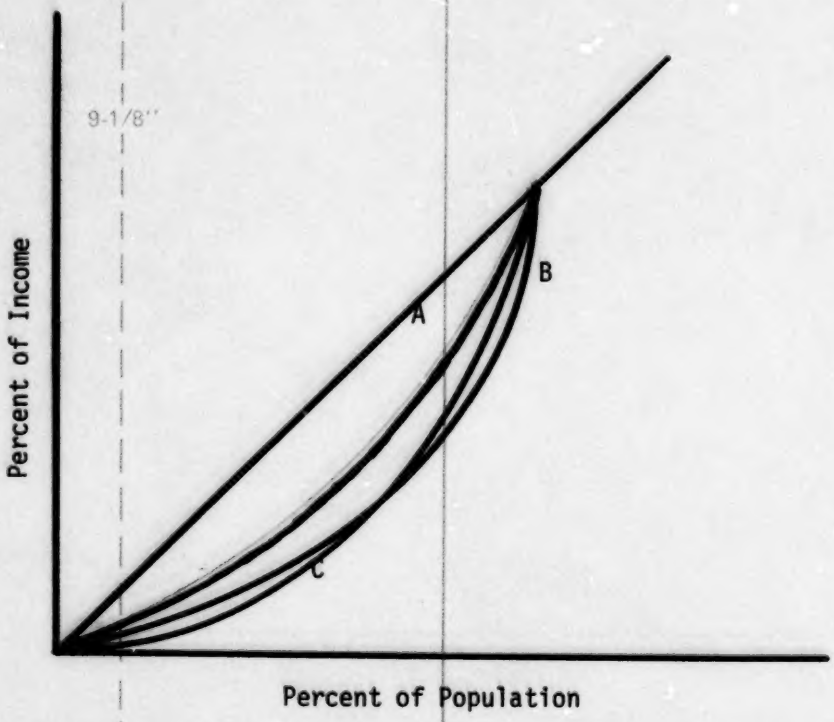

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Figure 1. Lorenz curves.

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$$X_i^Q = \frac{\Delta Y_i^Q}{Y_i^Q} \quad \text{for shared consequences}$$

$$X_i^Q = B_i^Q - C_i^Q \sum_{i=1}^{N} \frac{B_i}{C_i} \; * \quad \text{for earned rewards criterion}$$

where

B_i^Q = benefits in time period Q for individual i from the policy under analysis

C_i^Q = costs in time period Q for individual i from the policy under analysis

Y_i^Q = income in time period Q for individual i

$\bar{X}^Q$ and $\bar{Y}^Q$ are means for period Q.

$\alpha \geq 0$

N = number of individuals

The index I has the following properties:

1. It can rank all distributions pertinent to this analysis.

2. An equiproportional change in incremental and total income leaves I unchanged for equality and shared consequences. Balanced inflation does not affect equity under equality and shared consequences.

3. I is generally increased by an equiproportional rise in benefits and costs under earned rewards. Equity is unchanged under earned rewards only if benefits and costs are increased by a ratio equal to the cost-benefit ratio for society in general. To control for inflation, benefits and costs must be calculated in constant dollars.

4. I permits bias against inequality to be represented explicitly. As α approaches 0, that is, as the aversion to inequality is lessened, the level of inequality denoted by I approaches zero. As α goes to infinity, I goes to $R=1 - Y_i/\bar{Y}$ or $R = \bar{X} - X_i$ where Y_i or X_i is the minimum income or income ratio of individual i. If all Y_i (or X_i) are greater than zero, than $0 \leq I \leq 1$, otherwise $I \geq 0$. As α is raised, greater weight is attached to transfers affecting the lower tail of the distribution. So long as $\alpha > 0$, a positive transfer from a "richer" to a "poorer" person decreases I.

*If $\sum_{i=1}^{N} B_i$ or $\sum_{i=1}^{N} C_i = 0$, the ratio B_i/C_i can be set equal to 1 in order to make the function solvable.

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5. I is impartial to individuals: a permutation between individuals does not affect I. Inequity does not depend upon the identity of the disadvantaged individuals.

6. I does not change if the number of individuals in each class is raised proportionately. One disadvantaged person in a group of five is as inequitable as 100,000 disadvantaged in a population of half a million.

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Measurement of Incomes, Benefits, and Costs

Ideally, the estimate of the equality and intertemporal equity (if numerically estimated) would be based on an individual's welfare from real income, defined as the bundle of goods and services he receives, including leisure. Then changes in real income due to policy adoption, defined loosely as benefits and costs, could be calculated and their impact on individual welfare examined. Equity changes due to a policy change would then be directly tied, via the criteria, to changes in the distribution of benefits, costs, and total income.

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Measuring changes in real income is not a straightforward matter. A policy that changes prices nonproportionally changes real incomes. If, for example, the price of a good or service rose significantly, consumers would be expected to substitute other goods and services and reduce consumption of the higher-priced goods. While both income and substitution effects are likely to occur, it is quite difficult to compute both of these effects. Often, inadequate data are available on the nature of the demand curve and, as a consequence, it will often be necessary to limit the analysis to estimating income effects under an assumed demand curve.

It would be possible to allow for occupational preferences that generate differing average income levels. If, for example, it is believed that farmers derive more pleasure from their occupation than do others and that this fact compensates for a lower money income, such adjustments could be included in the computations. Determining the appropriate adjustment would obviously be highly subjective. Other simplifying assumptions must be made to permit the measurement of changes in real income. Using conventional cost-benefit terminology, all direct, internal, tangible, real, and pecuniary benefits and costs should be tabulated in an equity analysis. Most analyses, however, will consider only the effects of the policy on the estimates of income. Where other costs or benefits are at significant levels, the income estimates should be adjusted to reflect such impacts. Recreational benefits received or water-quality damages incurred are examples of such impacts that would be important in the case of soil erosion and sedimentation policies.

The estimates of the equity impacts under the shared-consequences criterion should be based upon a comparison of the total costs and total benefits each individual incurs as a result of the policy. When analyzing policies relating to the environment, it will often be necessary to make some estimates of the benefits received from nonmarket goods such as recreation benefits, flood control, or perhaps even aesthetic values. On the cost side,

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being forced to incur damages should be added to the dollar cost, such as tax payments and pollution-control expenditures.

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The estimates of equity under the earned-rewards criterion use the same types of information as those used for the shared-consequences criterion. The difference is that under earned rewards the costs would, ideally, be apportioned according to the benefits received, whereas under shared consequences all individuals would share in any net policy costs or benefits. Under earned rewards farmers who cause sedimentation problems and water users who benefit from clean water would share in the costs of erosion control. If farmers share in the costs of erosion control, the price of their products would reflect these costs at an appropriate level. The water users would, under an ideal policy, pay an appropriate share to reflect the benefit they received from the clean water used. In contrast, under the shared-consequences criterion, all in society would share in the cost of achieving the national objectives of productive soil and clean water. Of course, under the equity criteria discussed earlier, if the policy is to be judged equitable, the costs and benefits would need to be allocated to generate a more equal distribution of income, regardless of who generates the costs or enjoys the benefits. 6-1/2"

To use these criteria in policy analysis, one must estimate the equity performance before and after the adoption of each of several policy alternatives. Where implementation costs are significant, it will be appropriate to estimate the expected equity impacts during an implementation period as well as before and after policy adoption. In controlling agricultural nonpoint water pollution, it is possible that the major equity problems may occur during the implementation period. In the following, attention will be directed toward soil erosion control since it is the central factor in controlling agricultural water pollution.

Estimates of the equity impacts of policies under each criterion need to be made for the total population and with special reference to the various homogeneous groups that may be differentially impacted under the several policy alternatives. In the case of soil-erosion control, analyzing the impact on various classes of farmers will enable policy analysts to appreciate the equity consequences within the farm population, thus providing an estimate of the horizontal equity of a policy. By analyzing the impacts over the society, the analyst can estimate the overall impacts of the policy in question. In the case of soil erosion, the special groups to be analyzed would likely include farmers on various classes or types of land that would require varying types of erosion-control practices and thus have varying impacts. It may be necessary to analyze the impact on farm owners separately from the impact on farm operators who rent land. Other groups that may need to be considered are the businesses that would provide the conservation services and the water users. As an aside, it can be noted that special-interest groups that are adversely impacted under any of these criteria will likely make their case through the political process, and as such identify themselves as legitimate groups for consideration in such an analysis.

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Given that the equity indices have been calculated, the several policy alternatives can be ranked under each criterion. While people can be

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expected to have the same aversion to inequity for all policies under a given criterion, it is not reasonable to expect that they will have the same degree of aversion to inequity over the several criteria. In fact, some individuals will likely reject one or more of these equity criteria altogether. Thus it is not appropriate for the analyst to attempt to combine the indexes. This task remains for the political process.

In the example of soil-erosion control to achieve water quality goals it is likely that the analyst would find that a policy forcing farmers to adopt and pay for soil-erosion-control practices would be inequitable under the shared-consequences criterion because the farmer would be paying the entire cost of achieving the soil-control and water-quality objectives. Under the earned-rewards objective, such a policy would fare better in that the individual causing the damages would be forced to incur the cost of eliminating those damages. Under the equality criterion the results would depend on whether the farmer who had reduced income had more or less income than others in society. In this case, one would also expect to find inequities under the shared-consequences and equality criteria among farm groups because only those farmers who had erosion problems would be forced to incur the expenses of their control. By way of contrast, a policy that required tax payers to bear all or most of the cost of a soil-erosion-control program would rank highly under the shared-consequences criterion but poorly under the earned-rewards criterion. Each of these policies would probably be rated high under the intergenerational-equity criterion in that productivity would be maintained and sedimentation damages avoided. Having information of this type on a range of policy alternatives would allow planners and politicians to understand the reactions of interest groups.

Conclusions and Implications

While the techniques developed here have not yet been tested through application, it does appear that the broadening of the concept of equity to include several criteria reflecting values held by individuals in society will allow a policy analyst and a public decision maker to more accurately assess the impacts of a policy under analysis and to thereby assess the acceptance of that policy by individual citizens. Just as an assessment of the economic efficiency of a set of policy alternatives is not sufficient to determine whether the policies would be favorably received in the political arena, it is not possible to limit an equity analysis to the impacts on the distribution of income and expect that the political decision maker will find that analysis adequate to deal with the equity problems raised by his constituents. By understanding a more complete range of the equity impacts of the several policy alternatives, the decision maker can more accurately select the policies believed to be in the public interest.

In this report we also suggest an approach which shows some promise for quantifying the several equity criteria discussed, although we have presumed that it is impossible to develop a measurement technique for the intertemporal criterion. The primary value of the development of such measurement techniques is that the equity implication can be placed on a more nearly equal footing with the efficiency implications of alternative policy choices. Doing so should facilitate the policy makers' subjective analysis of the

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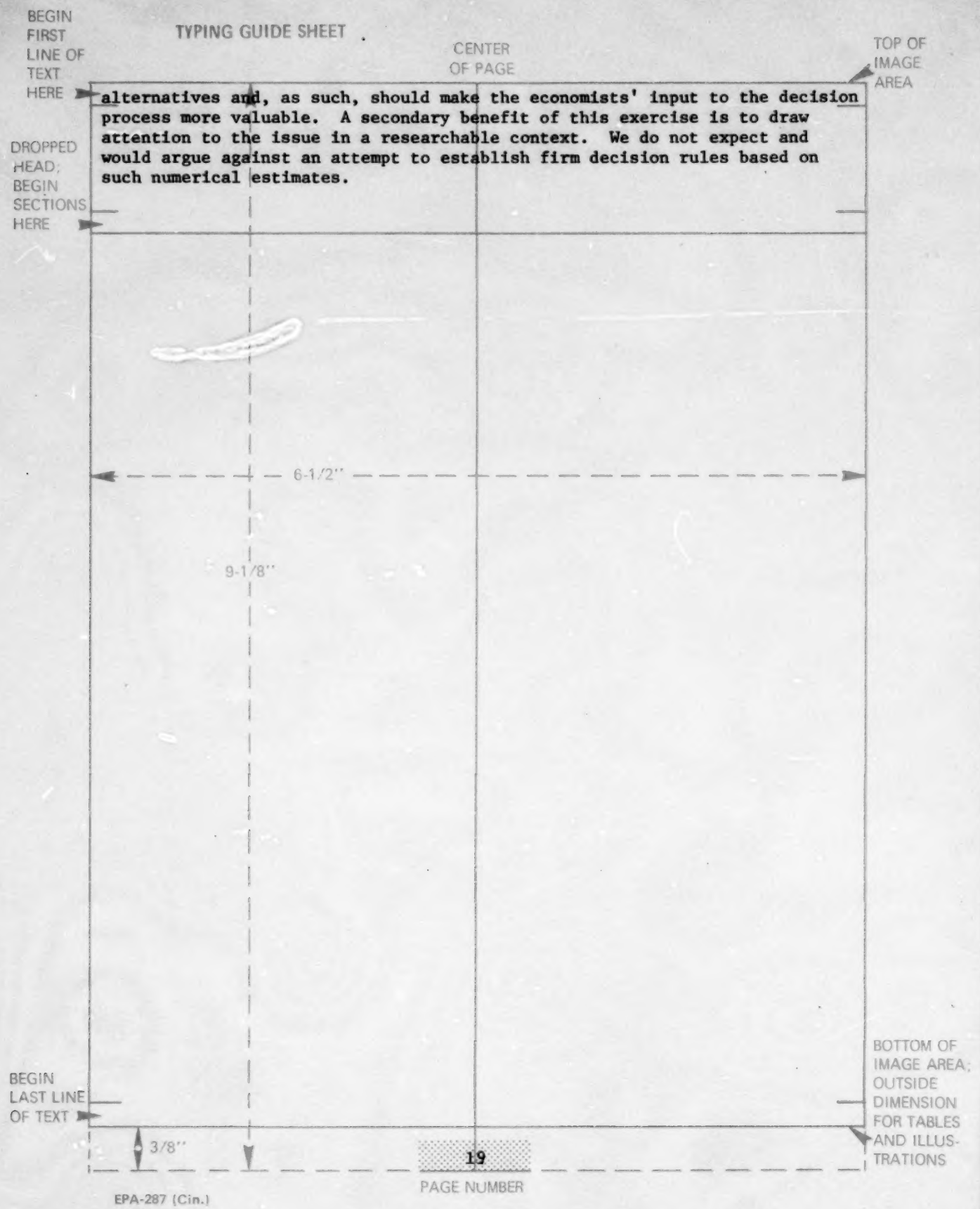
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alternatives and, as such, should make the economists' input to the decision process more valuable. A secondary benefit of this exercise is to draw attention to the issue in a researchable context. We do not expect and would argue against an attempt to establish firm decision rules based on such numerical estimates.
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